



**US Army Corps
of Engineers**
Waterways Experiment
Station

Preliminary Data Summary for January 1994, CERC Field Research Facility

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WES

The logo for the Waterways Experiment Station (WES), consisting of the letters "WES" in a bold, italicized font where each letter is composed of several parallel horizontal lines.

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January 1994

Preliminary Data Summary

by Field Research Facility

U.S. Army Corps of Engineers
Waterways Experiment Station
Coastal Engineering Research Center
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Preface

This report provides a summary of basic oceanographic, meteorological and bottom profile data for the month. The data were obtained as part of the Measurements and Analysis work units at the U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's Field Research Facility (FRF) in Duck, North Carolina. The FRF staff collected and analyzed these data. These summaries are intended to make the data readily available to all FRF users, and comments on their content and usefulness are invited.

1 Introduction

The U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's (CERC) Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. The research pier is a reinforced concrete structure supported on 0.9-m-diam steel piles spaced 12.2 m apart along the pier's length and 4.6 m apart across the width. The pier deck is 6.1 m wide and extends from behind the duneline to about the 6-m water depth contour at a height of 7.75 m above the National Geodetic Vertical Datum (NGVD) of the year 1929.

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local bathymetric, oceanographic, and meteorological conditions. This summary is intended to provide basic data as soon as possible after they are obtained. Questions and/or comments concerning the data may be directed to Mr. Clifford F. Baron at (919) 261-3511.

Chapter 2 presents the meteorological data; Chapters 3 through 6 present oceanographic data; Chapter 7 presents nearshore profiles and bathymetry; and Chapter 8, if included, documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used and their operational status during the month. Figure 2 shows weather and ocean conditions for the month. Table 2 and Figure 3 identifies the location of the instruments. The water depths at the wave gauges and current meters vary and may be determined from information contained in Figure 9. Other installation information is contained in Table 1.

Times given in the report are referenced to eastern standard time (EST).

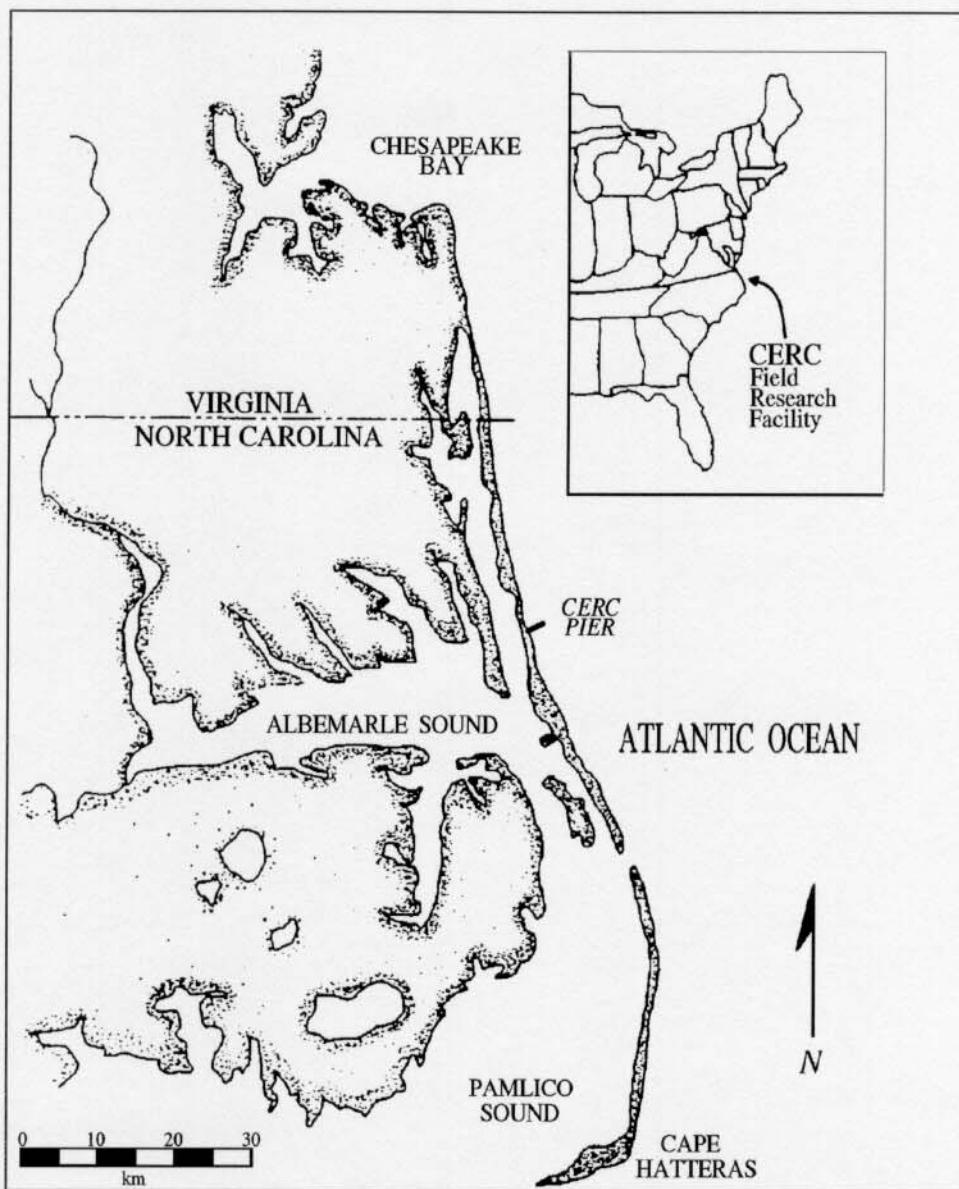


Figure 1. FRF Location Map

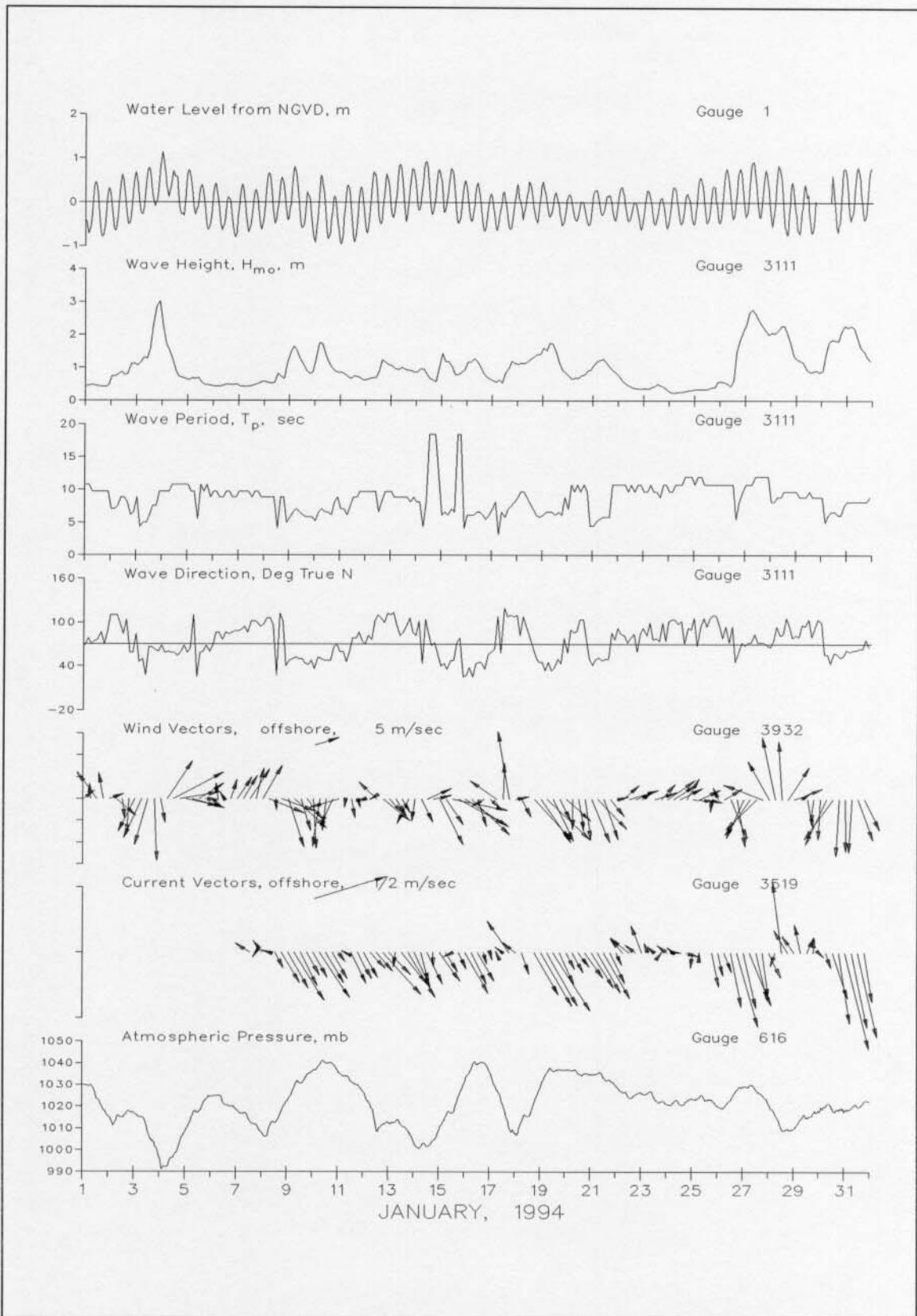


Figure 2. Month at a Glance

Table 1
Instrument Status/Data Availability

Gauge ID	Description/Remarks		January 1994																												
			Day of the month																												
1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0		
616	Atmospheric Pressure	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
604	Precipitation	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
624	Air Temperature	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
632	Anemometer on top of building	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
932	Anemometer at seaward end of pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
641	Pressure Gauge at station 780 on FRF pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
625	Baylor staff at station 1860 on FRF pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
3111	8 Meter Array 309 m north of FRF	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
111	Pressure Gauge 434 m north of FRF pier (0.9 km offshore)	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
630	Waverider buoy 4.0 km offshore	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
519	Current meter 434 m north of FRF pier (0.9 km offshore)	Gauge Status	-	-	-	-	-	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	-	-	-	-	-	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
1	NOAA tide station at seaward end of FRF pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Visual Observations (daily oceanographic and meteorological observations)			Daily observation	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

Gauge Status * = Operational / = Partial - = Non-Operational
 Data Collected * = All / = Partial - = None
 Visual Observations * = Complete / = Partial - = None

Table 2
Gauge Locations

Gauge ID	Description	Latitude Degrees N	Longitude Degrees W	FRF Coordinates Crossshore m	Longshore m	Gauge Depth NGVD, m	Water Depth NGVD, m
616	Barometer	36 10' 45.48"	75 44' 37.39"	11.60	569.00	-----	-----
632	Building Anemometer	36 10' 45.24"	75 44' 39.53"	21.45	515.83	19.94	-----
932	EOP Anemometer	36 11' 2.64"	75 44' 46.50"	585.20	517.30	19.50	-----
641	780 Pressure	36 10' 51.96"	75 44' 42.21"	239.11	516.64	-1.64	-1.96
625	1860 Baylor	36 11' 2.10"	75 44' 46.31"	568.00	516.64	Surface	-8.36
3111	8m Array	36 11' 15.90"	75 44' 38.88"	914.43	825.52	-7.76	-8.08
511	Pressure N Tripod	36 11' 17.17"	75 44' 34.15"	914.76	950.00	-6.70	-7.90
630	Waverider	36 12' 16.44"	75 47' 19.23"	3934.96	-2400.81	Surface	-17.00
519	Current N tripod	36 11' 17.17"	75 44' 34.15"	914.76	950.00	-5.30	-7.90
1	NOAA Tide	36 11' 2.95"	75 44' 46.76	596.49	514.20	Surface	-7.62

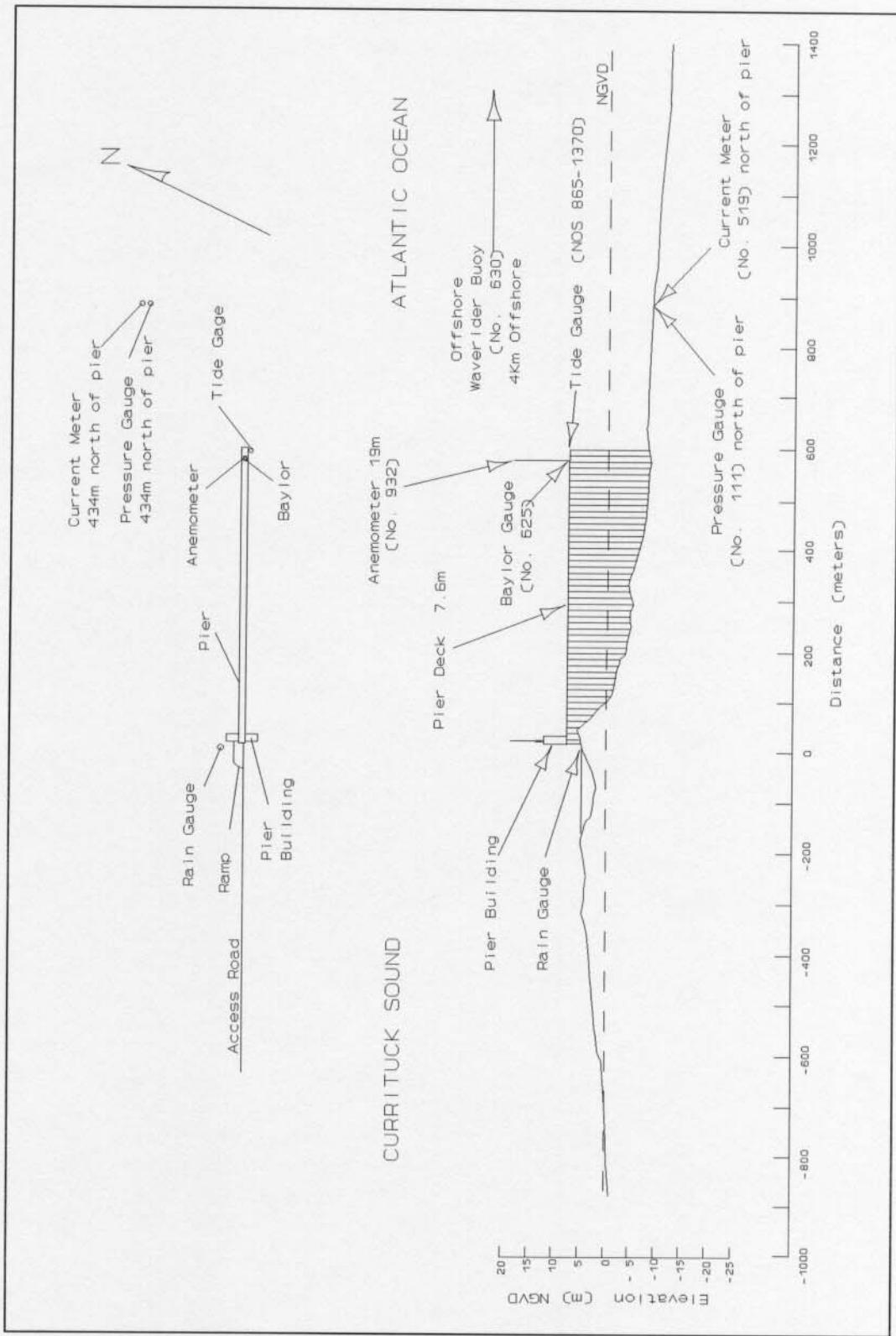


Figure 3. Instrument Locations, Elevations From NGVD

2 Meteorological Data

A variety of instruments have been installed at the FRF (Figure 3) to monitor the meteorological conditions. The data presented in Table 3 are collected and stored using a Digital Equipment Corporation VAX 11/750. For each instrument identified in Table 1, a log is maintained and the records are stored for future reference.

Winds were measured at the end of the pier at an elevation of 19 m (Figure 4) using a WeatherMeasure Skyvane anemometer. Monthly resultant wind speeds and directions are determined by vector averaging the data. Wind directions indicate where the wind is coming from. Temperature and atmospheric pressure means are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 3 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in.) -
 $mm \times .03937 = in.$
2. Millibars (mb) to inches of mercury (in. Hg) -
 $mb \times 0.02953 = in. Hg$
3. Degrees Celsius (C) to degrees Fahrenheit (F) -
 $(C \times 9/5) + 32 = F$
4. Meters per second (m/s) to knots (kn) -
 $m/s \times 1.943 = kn$

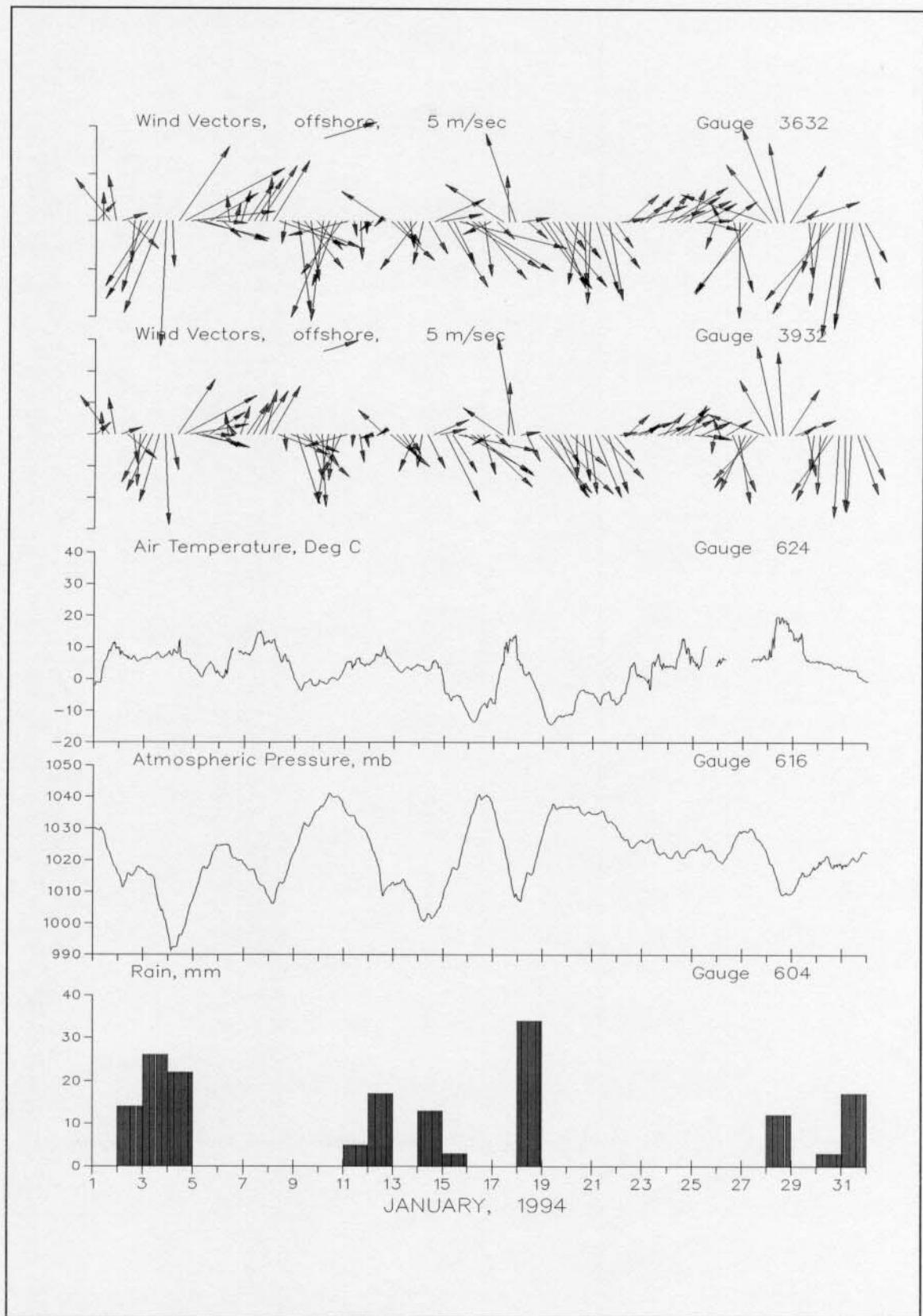


Figure 4. Meteorological Monthly Summary

Table 3
Meteorological Data

Jan 1994						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
1	100	3	225	-2.1	1030.2	0
	700	4	177	-0.8	1029.8	0
	1300	7	147	7.1	1024.5	0
	1900	6	171	11.5	1019.3	0
2	100	3	1	7.6	1015.2	0
	700	5	314	7.0	1013.3	14
	1300	5	353	6.7	1015.0	0
	1900	8	3	5.7	1018.0	0
3	100	8	23	6.5	1016.8	0
	700	10	21	6.9	1015.2	0
	1300	11	13	8.2	1009.6	6
	1900	14	357	6.8	1003.7	20
4	100	6	350	7.8	996.1	0
	700	10	209	8.1	992.5	22
	1300	12	237	6.5	996.3	0
	1900	8	258	6.0	1002.7	0
5	100	7	285	3.2	1008.8	0
	700	7	288	0.6	1015.4	0
	1300	6	233	4.4	1017.3	0
	1900	3	274	3.2	1022.5	0
6	100	3	314	0.9	1024.7	0
	700	4	173	1.4	1025.0	0
	1300	2	151	9.8	1021.3	0
	1900	5	195	8.8	1020.0	0
7	100	6	209	8.1	1018.7	0
	700	6	206	8.5	1016.9	0
	1300	8	209	14.7	1013.7	0
	1900	7	191	10.5	1011.9	0
8	100	9	206	11.5	1007.8	0
	700	8	294	9.0	1009.1	0
	1300	3	353	6.1	1012.5	0
	1900	7	292	5.2	1017.5	0
9	100	11	344	-0.6	1022.8	0
	700	9	316	-3.5	1028.5	0
	1300	7	345	-0.6	1030.9	0
	1900	6	327	-2.0	1034.1	0
10	100	11	357	-0.6	1036.5	0
	700	11	7	-1.6	1039.0	0
	1300	7	6	0.4	1040.2	0
	1900	7	20	0.3	1039.9	0

Table 3
Meteorological Data (continued)

Jan 1994						
		Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
Day	Hour					
11	100	6	71	4.4	1036.1	0
	700	2	5	4.8	1034.0	5
	1300	4	351	6.4	1031.7	0
	1900	2	348	4.5	1029.9	0
12	100	2	72	4.9	1026.5	0
	700	0		7.8	1021.2	0
	1300	5	137	8.6	1009.9	17
	1900	7	313	6.5	1011.8	0
13	100	4	319	4.0	1012.5	0
	700	4	330	2.0	1012.9	0
	1300	3	332	3.6	1011.6	0
	1900	6	21	3.8	1009.0	0
14	100	5	6	4.3	1003.4	6
	700	6	335	2.6	1001.4	7
	1300	5	242	5.5	1001.8	0
	1900	4	254	3.6	1004.5	0
15	100	11	336	-3.9	1009.5	0
	700	7	330	-6.7	1015.2	3
	1300	11	283	-5.0	1017.1	0
	1900	11	302	-7.8	1024.5	0
16	100	11	306	-12.0	1031.5	0
	700	11	317	-12.9	1037.3	0
	1300	6	345	-8.3	1039.2	0
	1900	3	57	-7.0	1040.2	0
17	100	3	315	-7.8	1036.0	0
	700	7	128	3.2	1028.2	0
	1300	8	181	10.2	1021.3	0
	1900	16	171	13.3	1011.3	0
18	100	3	257	5.5	1007.6	22
	700	4	336	1.2	1012.8	12
	1300	7	356	0.6	1015.5	0
	1900	12	321	-4.0	1021.6	0
19	100	11	329	-10.1	1029.0	0
	700	13	317	-14.2	1035.3	0
	1300	10	337	-12.0	1036.4	0
	1900	5	336	-11.6	1037.0	0
20	100	7	315	-10.9	1037.0	0
	700	7	359	-7.0	1036.8	0
	1300	7	352	-3.4	1035.3	0
	1900	9	353	-3.9	1035.2	0

Table 3
Meteorological Data (concluded)

Jan 1994						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
21	100	11	340	-4.7	1034.7	0
	700	9	320	-7.9	1035.1	0
	1300	10	343	-4.4	1033.2	0
	1900	5	324	-6.6	1032.3	0
22	100	2	256	-7.2	1029.7	0
	700	5	223	-4.5	1026.5	0
	1300	6	249	4.4	1024.5	0
	1900	4	1	1.1	1025.6	0
23	100	3	225	0.6	1026.1	0
	700	1	180	-3.2	1026.4	0
	1300	5	249	6.0	1024.3	0
	1900	4	217	3.5	1022.4	0
24	100	7	230	4.1	1021.1	0
	700	5	231	3.3	1022.0	0
	1300	5	239	10.7	1021.3	0
	1900	5	207	10.0	1022.5	0
25	100	4	274	5.6	1023.6	0
	700	5	242	4.3	1024.4	0
	1300	3	281	10.5	1022.9	0
	1900	3	6	Inoperative	1023.3	0
26	100	3	160	5.4	1020.3	0
	700	4	234	6.2	1019.9	0
	1300	9	340		1023.1	0
	1900	11	351		1027.8	0
27	100	9	21	Inoperative	1029.7	0
	700	10	30		1029.7	0
	1300	9	41	6.2	1028.0	0
	1900	8	113	6.7	1025.6	0
28	100	10	154	7.2	1021.3	0
	700	14	169	16.3	1017.0	0
	1300	13	177	19.4	1010.0	12
	1900	8	209	17.8	1010.0	0
29	100	6	246	12.4	1010.0	0
	700	3	231	13.2	1014.2	0
	1300	7	350	6.0	1015.3	0
	1900	6	5	5.6	1016.8	0
30	100	9	2	5.3	1017.9	0
	700	11	21	5.1	1020.2	0
	1300	11	31	4.7	1019.4	0
	1900	13	2	4.2	1019.0	3
31	100	12	359	3.2	1018.8	7
	700	12	2	3.0	1019.3	0
	1300	10	343	2.7	1020.2	10
	1900	8	337	0.1	1022.6	0
		Resultant		Mean	Mean	Total
		3	324	2.8	1021.3	166

3 Wave Data

Wave data are collected from a Baylor staff gauge (Gauge 625), two pressure wave gauges (641 and 511) and a Waverider buoy (Gauge 630) as shown in Table 1 and Figure 3. The data are collected, analyzed, and stored on optical disc using a Digital Equipment Corporation VAX 11/750 programmed to sample the gauges for two hour and forty-eight minute time frames. The sampling rate is two times per second which equals five contiguous 34 minute records per collection period. This report reflects the data collection periods of 0100, 0700, 1300, and 1900 EST. The results are based only on the first 34 minute record.

Wave height H_{mo} is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gauge has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 degrees of freedom calculated from a 34-min record. Peak wave period T_p is defined as the period associated with the maximum energy in the spectrum. When this analysis is complete, the data are written to optical disc.

Table 4 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 4 are average values computed from this data. Figure 5 is a time history of all H_{mo} and T_p values obtained for all gauges.

Differences in wave periods between wave gauges (Table 4 and Figure 5) may be the result of wave breaking, wave reformation, the presence of multiple wave trains containing nearly equal energy, and statistical variations in spectral estimations.

Table 4
Wave Data

Jan 1994									
Day	Hour	641		625		111		630	
		Pressure Gage Hmo,m	Tp,sec	Baylor 1860 Hmo,m	Tp,sec	Pressure Gage Hmo,m	Tp,sec	Waverider Hmo,m	Tp,sec
1	0100	0.13	19.7	0.36	10.7	0.42	9.9	0.44	9.9
	0700	0.19	10.7	0.42	9.9	0.44	10.3	0.47	11.2
	1300	0.17	17.1	0.40	9.9	0.39	9.5	0.44	9.9
	1900	0.19	17.1	0.40	10.3	0.40	10.3	0.42	10.3
	0100	0.50	6.1	0.66	6.6	0.70	6.8	0.84	7.0
2	0700	0.56	7.0	0.71	7.8	0.81	7.2	0.84	7.4
	1300	0.50	4.2	0.73	3.9	0.79	8.9	0.90	8.1
	1900	0.53	4.1	0.98	5.4	1.07	6.3	1.23	6.6
	0100	0.61	4.3	0.98	8.9	1.04	6.5	1.23	5.9
3	0700	0.77	4.6	1.22	5.1	1.22	4.9	1.35	8.1
	1300	0.79	5.3	1.29	6.3	1.39	5.7	1.43	5.3
	1900	0.95	7.0	2.42	7.4	2.81	7.8	3.18	7.6
	0100	1.32	9.5	2.29	9.2	2.46	9.9	2.62	8.8
4	0700	1.03	7.8	1.38	10.3	1.40	10.3	1.76	10.3
	1300	0.79	6.0	0.97	10.7	1.07	10.7	1.26	10.7
	1900	0.43	11.2	0.62	10.7	0.69	10.7	0.88	10.7
	0100	0.39	9.9	0.59	10.3	0.57	10.7	0.75	10.3
5	0700	0.42	4.5	0.64	10.3	0.63	11.2	0.82	5.7
	1300	0.43	5.7	0.57	10.7	0.57	5.4	0.70	5.3
	1900	0.22	3.5	0.49	11.7	0.47	9.5	0.55	10.7
	0100	0.24	4.7	0.44	8.9	0.42	10.7	0.52	11.2
6	0700	0.16	15.1	0.39	10.3	0.42	8.9	0.44	9.9
	1300	0.19	9.2	0.45	8.6	0.47	9.5	0.54	9.9
	1900	0.14	21.4	0.40	9.2	0.45	9.2	0.46	9.2
	0100	0.27	5.4	0.42	9.2	0.43	9.9	0.54	9.5
7	0700	0.23	4.9	0.43	9.9	0.38	10.3	0.50	9.2
	1300	0.25	4.9	0.42	9.2	0.43	8.6	0.52	9.2
	1900	0.32	5.1	0.52	9.2	0.49	9.9	0.65	9.5
	0100	0.42	6.1	0.56	9.5	0.53	8.6	0.76	9.2
8	0700	0.32	8.9	0.46	9.2	0.53	9.2	0.64	8.6
	1300	0.48	3.9	0.69	3.9	0.71	3.9	0.80	3.9
	1900	0.41	4.8	0.59	6.0	0.65	9.2	0.74	9.5
	0100	0.89	5.2	1.28	5.1	1.42	5.6	1.59	5.5
9	0700	1.00	6.5	1.34	6.3	1.64	7.0	1.63	7.0
	1300	0.68	5.9	1.09	6.3	1.18	6.1	1.34	5.7
	1900	0.57	4.7	0.79	6.1	0.82	6.0	0.98	5.7
	0100	0.71	4.9	1.05	5.0	1.04	5.6	1.36	5.5
10	0700	1.06	6.8	1.64	7.2	1.73	7.0	1.90	7.0
	1300	0.59	6.3	1.13	6.6	1.24	6.5	1.39	6.5
	1900	0.54	5.0	0.89	5.9	0.88	6.6	1.07	6.1

Table 4
Wave Data (continued)

		Jan 1994											
Day	Hour	641			625			111			630		
		Pressure Gage	Baylor	1860	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Pressure Gage	Waverider	Hmo,m
		Hmo,m	Tp,sec		Hmo,m	Tp,sec		Hmo,m	Tp,sec		Hmo,m	Tp,sec	
11	0100	0.50	3.7		0.88	7.2		0.89	7.4		1.04	7.2	
	0700	0.39	5.7		0.71	7.0		0.73	6.5		0.82	6.3	
	1300	0.38	4.7		0.67	8.9		0.73	7.4		0.79	8.6	
	1900	0.40	4.8		0.65	4.5		0.70	9.5		0.77	9.2	
	0100	0.29	16.0		0.60	9.9		0.60	9.9		0.67	9.2	
12	0700	0.46	4.8		0.69	4.8		0.69	4.9		0.75	5.0	
	1300	0.53	6.5		0.77	6.5		0.80	6.3		1.02	6.6	
	1900	1.00	8.9		1.18	9.5		1.17	8.6		0.38	11.7	
	0100	0.62	9.9		0.95	9.5		1.04	9.9		0.41	9.5	
13	0700	0.68	9.2		0.88	9.2		0.86	8.9		0.42	8.9	
	1300	0.53	8.3		0.87	8.9		0.96	9.2		1.07	9.2	
	1900	0.58	8.6		0.85	8.3		0.94	8.3		1.03	8.1	
	0100	0.43	3.8		0.80	8.9		0.78	8.9		0.90	8.6	
14	0700	0.60	4.4		0.91	4.1		0.99	4.1		1.04	8.3	
	1300	0.35	17.1		0.66	18.3		0.71	9.2		0.78	8.9	
	1900	0.27	18.3		0.51	18.3		0.58	18.3		0.58	17.1	
	0100	0.92	5.0		1.26	5.3		1.31	5.3		1.39	5.2	
15	0700	0.80	5.7		1.01	6.1		1.12	6.1		1.35	6.6	
	1300	0.48	6.0		0.77	6.3		0.82	6.8		1.01	7.8	
	1900	0.57	5.1		0.81	5.6		0.80	5.4		1.02	5.2	
	0100	0.79	6.1		1.02	6.3		1.13	6.3		1.42	6.6	
16	0700	0.84	6.1		1.12	6.1		1.28	6.5		1.55	6.8	
	1300	0.71	6.5		1.04	6.5		1.07	6.5		1.26	6.6	
	1900	0.50	5.4		0.74	5.5		0.74	6.8		0.96	5.6	
	0100	0.34	4.6		0.60	6.3		0.62	4.5		0.68	5.6	
17	0700	0.34	3.0		0.68	3.3		0.56	7.2		0.74	7.6	
	1300	0.49	5.5		0.75	5.5		0.74	5.7		1.12	5.9	
	1900	0.59	7.6		1.02	8.3		1.13	7.4		1.38	7.4	
	0100	0.73	9.9		1.10	8.9		1.16	8.9		1.26	10.3	
18	0700	0.71	4.5		1.06	9.9		1.05	10.3		1.35	9.5	
	1300	0.75	5.6		1.12	5.7		1.27	9.8		1.40	10.2	
	1900	0.65	5.0		1.23	6.1		1.34	6.6		1.62	6.3	
	0100	0.91	6.0		1.43	6.1		1.58	5.9		1.64	6.5	
19	0700	0.73	6.5		1.48	6.5		1.60	6.5		1.80	6.5	
	1300	0.87	6.8		1.42	6.3		1.57	6.6		1.80	7.0	
	1900	0.55	5.2		0.90	6.0		0.94	6.3		1.11	6.3	
	0100	0.42	4.9		0.71	6.6		0.76	7.2		0.88	6.5	
20	0700	0.38	3.2		0.72	9.9		0.66	9.2		0.80	11.2	
	1300	0.40	4.1		0.75	4.1		0.69	10.3		0.79	10.3	
	1900	0.49	3.8		0.88	4.1		0.85	9.9		0.98	9.5	

Table 4
Wave Data (concluded)

Jan 1994									
Day	Hour	641		625		111		630	
		Pressure Gage Hmo,m	Tp,sec	Baylor 1860 Hmo,m	Tp,sec	Pressure Gage Hmo,m	Tp,sec	Waverider Hmo,m	Tp,sec
21	0100	0.62	4.5	0.99	4.4	1.01	10.7	1.15	4.8
	0700	0.69	5.2	1.14	5.4	1.17	5.6	1.41	5.2
	1300	0.76	5.5	1.15	5.7	1.13	5.6	1.40	5.7
	1900	0.50	4.9	0.88	6.0	0.92	10.7	1.03	5.7
	0100	0.36	10.7	0.71	10.7	0.79	10.7	0.82	10.7
22	0700	0.17	10.7	0.51	10.7	0.49	10.7	0.52	9.9
	1300	0.15	10.7	0.39	10.3	0.44	10.3	0.44	9.9
	1900	0.12	10.3	0.37	10.3	0.37	10.3	0.37	10.7
	0100	0.25	5.7	0.32	9.9	0.34	10.3	0.42	10.3
23	0700	0.16	10.3	0.36	10.3	0.39	10.3	0.43	9.9
	1300	0.26	3.9	0.52	9.9	0.47	9.9	0.55	9.5
	1900	0.19	4.0	0.41	9.9	0.39	9.9	0.45	10.3
	0100	0.13	10.7	0.26	10.3	0.27	10.3	0.30	9.9
24	0700	0.13	9.9	0.20	9.9	0.23	10.7	0.27	10.3
	1300	0.11	12.2	0.23	9.9	0.26	10.3	0.30	9.9
	1900	0.14	12.2	0.27	11.7	0.31	11.7	0.35	12.2
	0100	0.14	11.2	0.30	11.7	0.34	12.2	0.36	11.2
25	0700	0.18	11.2	0.28	10.7	0.35	11.2	0.38	11.7
	1300	0.13	11.2	0.28	11.2	0.37	11.7	0.38	11.2
	1900	0.20	11.2	0.37	10.7	0.37	11.2	0.49	11.2
	0100	0.33	5.3	0.53	5.4	0.60	11.2	0.60	10.7
26	0700	0.32	4.8	0.47	11.2	0.52	10.7	0.52	11.2
	1300	0.33	2.8	0.55	10.3	0.45	11.2	0.65	10.7
	1900	1.08	7.6	1.53	7.8	1.79	7.8	1.98	7.2
	0100	0.71	10.7	2.04	10.7	2.18	9.5	2.44	10.3
27	0700	1.24	11.2	2.51	10.3	2.65	11.2	2.77	11.2
	1300	0.73	12.2	2.29	12.2	2.45	12.9	2.69	12.2
	1900	1.20	7.2	2.11	12.2	2.37	11.7	2.16	10.3
	0100	0.66	9.1	1.82	8.1	2.05	8.1	2.21	7.6
28	0700	1.14	8.3	2.07	8.6	2.18	8.6	2.34	8.3
	1300	0.73	8.8	2.06	9.9	2.15	8.9	2.28	10.3
	1900	0.99	9.9	1.67	9.9	1.65	10.7	2.03	9.9
	0100	0.50	10.3	1.17	9.5	1.17	10.3	1.32	9.9
29	0700	0.78	9.2	1.04	9.9	1.11	9.5	1.19	8.9
	1300	0.44	9.5	0.79	9.5	0.87	9.5	0.89	9.9
	1900	0.50	8.6	0.92	9.2	0.89	10.3	1.05	8.9
	0100	0.36	3.9	0.81	8.9	0.83	9.2	0.94	9.9
30	0700	0.79	5.7	1.57	5.6	1.72	5.7	1.88	5.7
	1300	0.56	6.1	1.59	6.8	1.85	6.8	2.13	6.8
	1900	0.81	6.3	1.77	6.1	1.86	6.5	2.28	6.0
	0100	0.73	7.4	2.02	7.8	2.24	7.8	2.63	7.8
31	0700	0.82	7.2	1.98	7.4	2.21	8.1	2.30	7.8
	1300	0.69	6.0	1.43	7.8	1.63	8.1	1.75	9.5
	1900	0.67	5.0	1.29	7.4	1.36	8.1	1.53	7.0
	Mean	0.53	7.5	0.93	8.3	0.99	8.6	1.10	8.5
	Std dev	0.28	3.6	0.52	2.6	0.58	2.2	0.64	2.2

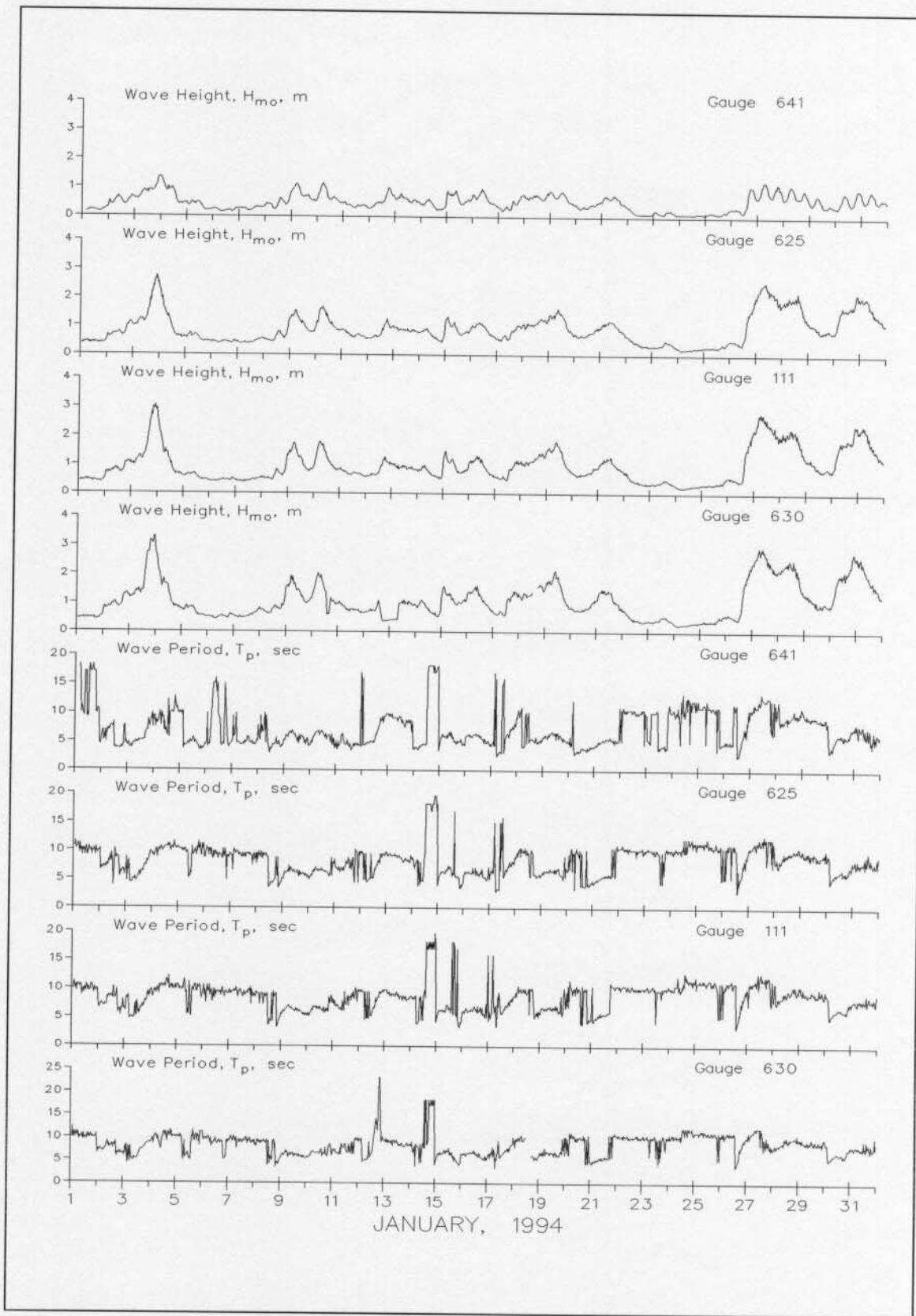


Figure 5. Time History of Wave Heights and Periods

4 Current Data

Current data (Table 5) are collected from a Marsh-McBirney electromagnetic biaxial current meter and by visually observing the movement of small drogues on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier, approximately 12 m offshore (Table 6).

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or off-shore (eastward). All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the cross-shore and longshore data. Current directions indicate the direction that the current is moving towards. Current data are plotted in Figure 2.

Table 5
Current Meter Data - Gauge 519

JANUARY 1994													
Day	Time	Cross Long				Cross Long				Cross Long			
		Shore	Shore	Speed	Dir	Shore	Shore	Speed	Dir	Shore	Shore	Speed	Dir
1	100					1300	1	25	26	157			
	700					1900	2	22	22	155	22	100	0
	1300					12	100	2	21	21	154	700	-3
	1900					700	5	15	16	140	1300	-7	-12
2	100					1300	5	17	18	143	1900	-3	14
	700					1900	13	39	41	142	23	100	0
	1300	Gauge				13	100	8	20	22	140	700	-7
	1900					700	-4	10	11	187	1300	-2	22
3	100					1300	7	28	29	145	1900	1	313
	700					1900	5	38	38	152	23	100	0
	1300					14	100	1	28	28	158	700	-7
	1900					700	-2	23	23	166	1300	1	312
4	100					1300	2	26	26	156	1900	7	312
	700	Inoperative				1900	-3	10	11	180	25	100	-4
	1300					15	100	5	25	26	148	700	0
	1900					700	2	16	17	152	1300	-14	218
5	100					1300	-5	1	7	241	1900	-3	26
	700					1900	1	13	13	158	26	100	-2
	1300					16	100	4	34	34	153	700	0
	1900					700	1	26	26	157	1300	-6	17
6	100					1300	3	24	24	153	1900	-5	17
	700					1900	0	9	9	167	27	100	-5
	1300					17	100	0	6	6	165	700	0
	1900					700	0	-1	2	338	1300	-4	169
7	100					1300	-2	-5	7	313	1900	-7	166
	700					1900	-4	-27	28	329	28	100	1
	1300		-5	-9	12	18	100	-4	-10	12	313	700	-5
	1900		-2	3	4	700	0	17	17	162	1300	13	354
8	100	-2	-9	11	326	1300	7	29	30	147	1900	-2	26
	700	-3	-2	5	289	1900	4	35	36	154	29	100	-2
	1300	1	13	13	155	1900	6	45	45	153	700	4	329
	1900	3	26	26	153	700	5	45	45	153	1300	-9	350
9	100	3	30	30	153	1300	8	50	51	151	1900	5	12
	700	6	41	41	152	1900	1	26	26	158	30	100	2
	1300	2	28	28	156	700	2	17	17	153	700	0	164
	1900	2	19	19	154	20	100	1	13	14	154	1300	-2
10	100	2	21	21	154	1300	3	13	13	146	1900	-11	172
	700	7	39	40	150	1900	5	22	22	148	31	100	-10
	1300	3	26	26	152	21	100	5	30	31	151	700	-9
	1900	3	22	22	153	700	4	34	34	153	1300	-9	
11	100	2	8	8	146	1300	5	38	39	153	1900	-7	172
	700	-1	-1	2	299	1900	1	25	25	157	1900	-7	172

KEY:

- +cross-shore = offshore, cm/sec
- cross-shore = onshore, cm/sec
- +longshore = south, cm/sec
- longshore = north, cm/sec
- Speed = Resultant speed, cm/sec
- Dir = Resultant direction, degrees true north

Table 6
Visually Observed Current Data

Day	Jan 1994											
	Pier End				Mid-Surf Zone				Beach			
	Cross Shore	Long Shore	Speed	Dir	Cross Shore	Long Shore	Speed	Dir	Location	Speed	Dir	
1	0	-51	51	340	-8	-30	31	326	South	23	N	
2	0	32	32	160	10	-16	19	11	South	91	N	
3	0	30	30	160	0	61	61	160	North	30	S	
4	22	-17	28	31	0	-68	68	340	South	23	N	
5	8	11	13	123	0	20	20	160	North	23	S	
6	0	-27	27	340	0	-51	51	340	South	5	N	
7	14	-23	27	11	6	-20	21	357	South	46	N	
8	0	25	25	160	0	-17	17	340	South	6	N	
9	0	51	51	160	0	76	76	160	North	81	S	
10	0	68	68	160	0	102	102	160	North	107	S	
11	0	28	28	160	0	16	16	160	North	12	S	
12	-14	28	31	187	0	0	0	0	North	17	N	
13	0	29	29	160	0	0	0	0	North	0		
14	11	38	40	143	0	30	30	160	North	11	S	
15	9	30	32	143	0	102	102	160	North	46	S	
16	0	41	41	160	0	87	87	160	North	61	S	
17	0	-23	23	340	0	-61	61	340	South	21	N	
18	0	30	30	160	5	-16	16	357	South	0		
19	0	102	102	160	0	87	87	160	North	46	S	
20	0	14	14	160	0	44	44	160	North	14	S	
21	0	68	68	160	0	152	152	160	North	30	S	
22	32	16	36	70	14	-23	27	11	South	6	S	
23	0	-41	41	340	0	-13	13	340	South	0		
24	13	-13	19	25	0	-6	6	340	South	5	N	
25	8	9	12	118	0	-5	5	340	North	5	N	
26	0	24	24	160	0	7	7	160	North	14	N	
27	0	36	36	160	-23	76	80	177	North	20	S	
28	0	-122	122	340	-30	-102	106	323	South	34	N	
29	0	-14	14	340	0	-30	30	340	South	20	N	
30	0	51	51	160	0	76	76	160	North	30	S	
31	0	87	87	160	0	55	55	160	North	91	S	

KEY:

- +cross-shore = offshore, cm/sec
- cross-shore = onshore, cm/sec
- +longshore = south, cm/sec
- longshore = north, cm/sec
- Speed = Resultant speed, cm/sec
- Dir = Resultant direction, degrees true north

5 Visual Observations

Visual wave direction measurements (Table 7) of both the primary wave train (i.e. that having the higher wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves) are taken daily at the seaward end of the pier. The direction of the primary wave train just north of the seaward end of the pier is also determined using a Raytheon Marine Pathfinder radar and measuring the alignment of the wave crests at approximately the same location as the visual measurements. The pier axis (considered perpendicular to the beach at the FRF) is oriented 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and visibility are also taken daily at the seaward end of the pier. A Bucket Thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The temperature is then read, and a hydrometer is used to determine the density. A Secchi disc is used to determine the depth of visibility.

Table 7
Visual Observations

Day	Time	Wave Approach Angle at Pier End deg from True N		Radar Wave Angle deg from True N	Width of Surf Zone, m	Water Characteristics at Pier End		
		Primary	Secondary			Temp., C	Density g/cc	Secchi Vis., m
1	1125	110		Radar inoperative all month	24	6.7	1.0239	1.5
2	1120	90	20		21	8.6	1.0256	0.6
3	0725	90	45		113	8.1	1.0246	1.8
4	0725	95	40		145	7.5	1.0230	0.3
5	0720	90	40		64	7.2	1.0250	0.6
6	0725	50	95		9	7.2	1.0250	1.2
7	0725	95			6	8.3	1.0250	1.8
8	0945	100			9	8.9	1.0258	1.5
9	1120	40	60		152	6.7	1.0258	0.3
10	0730	50	30		158	5.6	1.0244	0.3
11	0920	90	55		12	5.6	1.0235	1.5
12	0815	60	120		12	6.7	1.0230	2.4
13	0705	100	40		18	5.8	1.0212	2.7
14	0740	40			27	5.8	1.0220	2.1
15	0905	30			76	5.0	1.0229	2.7
16	1053	40			94	3.1	1.0250	0.9
17	0732	100	55		12	3.9	1.0250	0.9
18	0740	100	20		104	6.4	1.0252	0.9
19	0736	25			223	1.7	1.0250	0.9
20	0850	30	90		82	1.1	1.0240	1.5
21	0845	50			122	0.8	1.0225	1.5
22	1005	100			8	1.4	1.0220	1.2
23	0905	90	40		6	2.2	1.0224	2.1
24	0704	95			3	5.6	1.0260	1.2
25	0725	100	120		3	4.4	1.0226	2.4
26	0733	40	90		11	4.7	1.0222	2.7
27	0716	50			340	4.4	1.0223	0.9
28	0850	90			226	4.7	1.0243	0.6
29	0833	100	75		29	6.4	1.0256	0.9
30	0903	40	90		174	5.3	1.0260	0.9
31	0745	40			195	3.3	1.0215	0.9

6 Water Levels

Since 1978, the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS) has operated a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A Leupold-Stevens digital recording float-type tide gauge is used to collect instantaneous water level data every 6 minutes throughout the month.

The variation in water level during the month is shown in Figure 6 along with a list of means and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water level. Table 8 contains the range, high, low, and mean water level for each 12.42-hr tidal cycle.

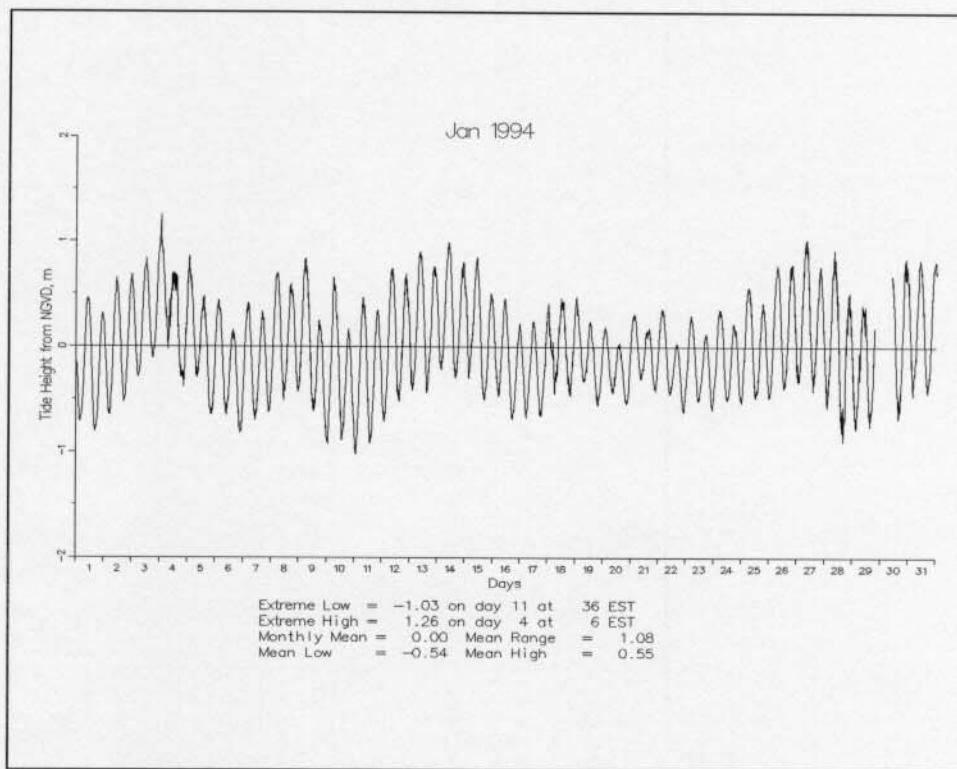


Figure 6. Water Level Time History

Table 8
Water Levels, m NGVD

JAN 1994 Tide Levels																					
High			Low			Range	High			Low			Range	Low							
Day	Time	m	Day	Time	m	m	Day	Time	m	Day	Time	m	m	m							
1	0918	0.46	1	0236	-0.71	-0.13	1.17	16	2254	0.22	16	1630	-0.69	-0.23	0.91						
1	2206	0.31	1	1536	-0.81	-0.25	1.12	17	1018	0.25	17	0430	-0.68	-0.20	0.92						
2	1006	0.65	2	0442	-0.65	-0.02	1.30	18	0000	0.41	17	1624	-0.66	-0.18	1.06						
2	2306	0.68	2	1618	-0.53	0.07	1.21	18	1100	0.47	18	0524	-0.45	0.05	0.91						
3	1130	0.84	3	0424	-0.29	0.25	1.13	19	0006	0.48	18	1900	-0.46	-0.01	0.94						
4	0006	1.26	3	1724	-0.11	0.45	1.37	19	1154	0.24	19	0606	-0.33	-0.05	0.57						
4	0236	0.76	4	0624	-0.02	0.44	0.78	20	0118	0.20	19	1830	-0.55	-0.18	0.75						
5	0024	0.86	4	1930	-0.38	0.17	1.24	20	1336	0.04	20	0730	-0.44	-0.19	0.48						
5	1318	0.48	5	0718	-0.30	0.11	0.77	21	0218	0.31	20	1936	-0.54	-0.12	0.85						
6	0136	0.44	5	1912	-0.65	-0.12	1.09	21	1512	0.18	21	0812	-0.30	-0.04	0.49						
6	1406	0.16	6	0842	-0.65	-0.21	0.81	22	0242	0.36	21	2054	-0.42	-0.02	0.79						
7	0248	0.41	6	2030	-0.82	-0.22	1.23	22	0518	0.13	22	0918	-0.45	-0.18	0.58						
7	1518	0.33	7	0906	-0.70	-0.19	1.03	23	0324	0.30	22	2100	-0.62	-0.17	0.92						
8	0412	0.70	7	2054	-0.62	0.01	1.33	23	1636	0.13	23	0936	-0.51	-0.19	0.64						
8	1554	0.60	8	1006	-0.52	0.09	1.12	24	0412	0.35	23	2154	-0.59	-0.11	0.95						
9	0442	0.84	8	2206	-0.44	0.18	1.27	24	1630	0.22	24	1106	-0.50	-0.13	0.73						
9	0654	0.51	9	1142	-0.62	-0.12	1.12	25	0500	0.57	24	2318	-0.53	0.02	1.09						
10	0454	0.66	10	0000	-0.92	-0.20	1.58	25	1736	0.41	25	1118	-0.48	-0.04	0.90						
10	0748	0.29	10	1206	-0.89	-0.29	1.18	26	0606	0.78	25	2254	-0.48	0.13	1.26						
11	0642	0.47	11	0036	-1.03	-0.30	1.49	26	1906	0.79	26	1206	-0.39	0.20	1.18						
11	1848	0.35	11	1300	-0.91	-0.25	1.26	27	0712	1.02	27	0012	-0.33	0.33	1.35						
12	0706	0.74	12	0106	-0.71	-0.02	1.45	27	1924	0.77	27	1312	-0.42	0.21	1.19						
12	1936	0.69	12	1342	-0.52	0.09	1.21	28	0712	0.93	28	0130	-0.58	0.17	1.50						
13	0754	0.91	13	0136	-0.42	0.23	1.33	28	2030	0.51	28	1454	-0.90	-0.13	1.41						
13	2000	0.76	13	1400	-0.44	0.23	1.20	29	0800	0.40	29	0224	-0.78	-0.16	1.18						
14	0824	0.99	14	0242	-0.21	0.38	1.20	29	1107	No data for this tide cycle											
14	2148	0.81	14	1448	-0.30	0.25	1.10	29	2332	No data for this tide cycle											
15	0942	0.85	15	0236	-0.30	0.31	1.15	30	2118	0.84	30	1500	-0.68	0.09	1.52						
15	2142	0.51	15	1548	-0.50	0.00	1.01	31	0948	0.84	31	0336	-0.47	0.22	1.30						
16	0948	0.46	16	0436	-0.47	0.00	0.93	31	2254	0.81	31	1612	-0.44	0.15	1.26						

7 Bathymetry

A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using the CRAB-Geodimeter surveying system; a Geodimeter 140-T self-tracking, electronic theodolite, distance meter, in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 7 shows the last survey in December 1993 and the survey(s) in January 1994 on profile line 188, located 517 m south of the pier.

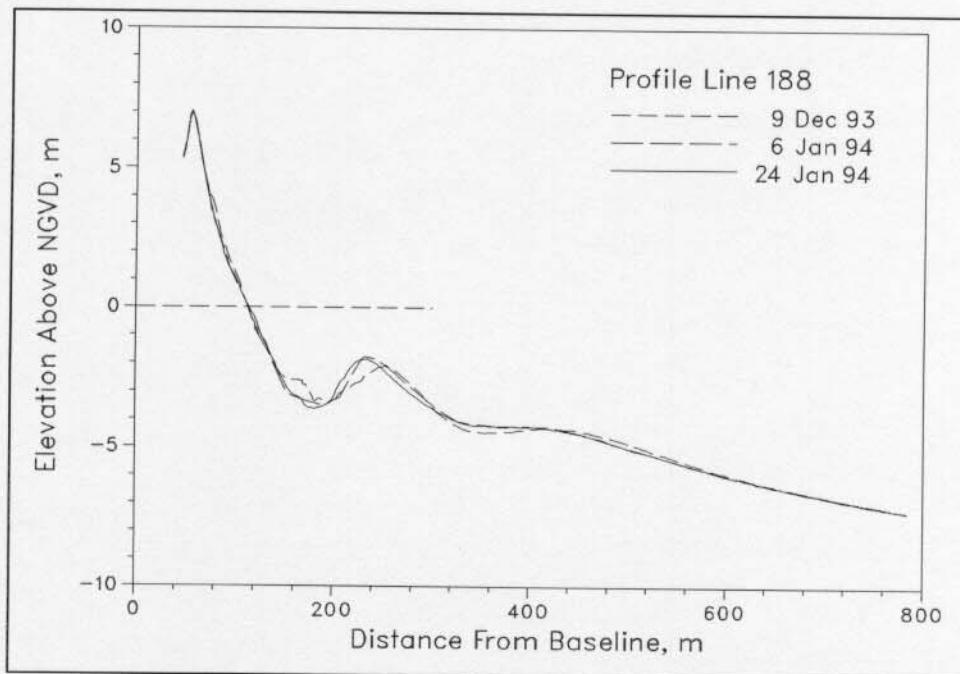


Figure 7. Monthly CRAB Profiles on Profile Line 188.

The profile envelope (Figure 8) reflects the maximum changes that occurred on the profile during 1994. Cross-hatched areas indicate changes to the annual envelope which occurred in January.

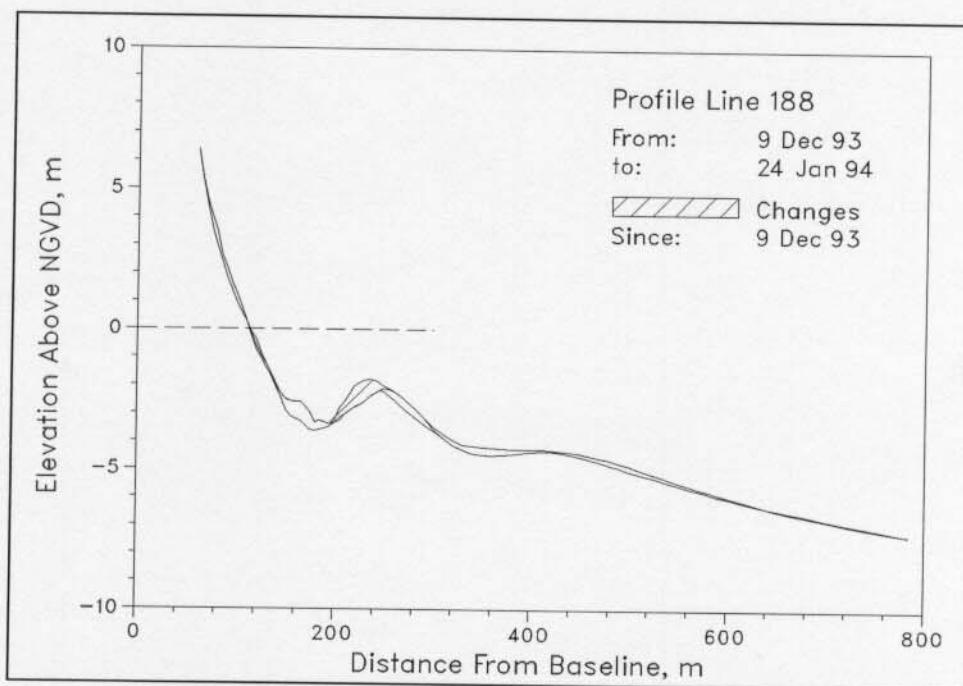


Figure 8. Profile Envelope - Profile Line 188.

B. Bathymetry. Figure 9 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 24 January. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition.

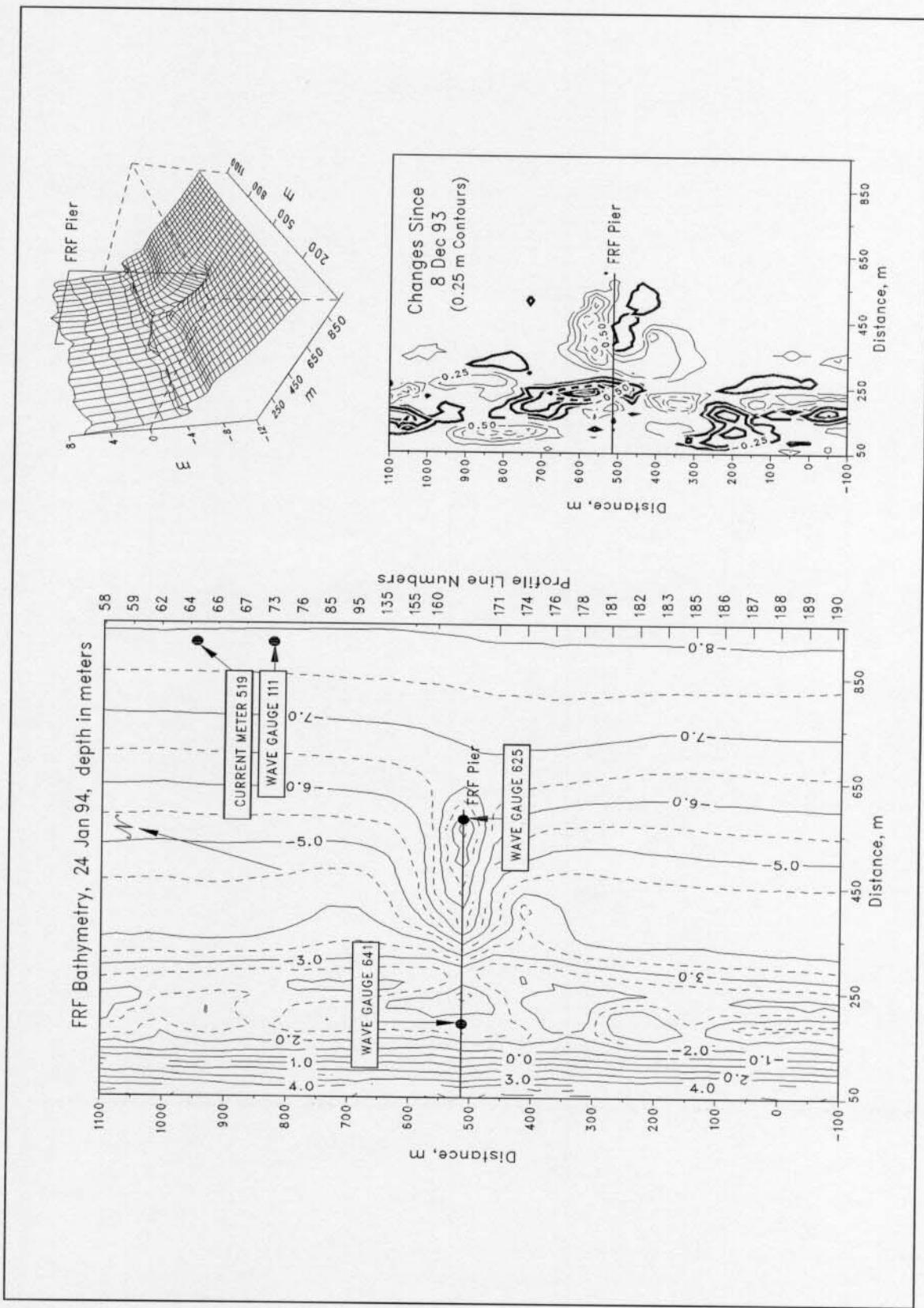


Figure 9. FRF Bathymetry, Depths Relative to NGVD

8 Special Events

A. Storm Data Collection. The following list identifies times when the wave height H_{mo} at the seaward end of the pier exceeded 2 m.

<u>Start</u>	<u>End</u>
3 Jan (1708)	4 Jan (0316)
26 Jan (2342)	28 Jan (1600)
30 Jan (2042)	31 Jan (0542)

B. Storm Synopsis.

3-4 Jan A low pressure system which formed off the Georgia - South Carolina coast, moved quickly along the North Carolina coast. Maximum onshore winds (NE) reached 13 m/s at 2042 on 3 January. The minimum atmospheric pressure was 991 mb. The maximum H_{mo} , at gauge 630, reached 3.14 m ($T_p=7.76$ s) at 1934 EST on 3 January. There was 48 mm of precipitation.

26-28 Jan A Southeasterly moving Canadian high pressure system generated onshore winds (NE) that reached 10.8 m/s at 0508 on 27 January. The maximum H_{mo} , at gauge 630, reached 2.97 m ($T_p=12.19$ s) at 0916 EST on 27 January. There was 12 mm of precipitation.

30-31 Jan Northeasterly winds were funneled between a Canadian high pressure system and a low pressure system offshore of Cape Hatteras, NC. Maximum onshore winds (NE) reached 13.4 m/s at 1516 EST on 30 January. The maximum H_{mo} , at gauge 630, reached 2.78 m ($T_p=7.53$ s) at 2200 EST on 31 January. There was 20 mm of precipitation.

Distribution List

Government Agencies:

Back Bay National Wildlife Refuge
USACE-OCE
USACE-SAD
USACE-NAP
USACE-SAW
USACE-WES
NAVSAC
NOAA/NOS/OMS
National Marine Fisheries
U.S. Geological Survey
U.S. Library of Congress
U.S. National Park Service
U.S. National Weather Service
U.S. Naval Academy
U.S. Naval Civil Eng. Lab
U.S. Naval Oceanographic Off.
U.S. Naval Research Lab

Colleges/Universities:

Bucknell University
California Inst. of Tech.
Duke Marine Lab
East Carolina University
Florida Inst. of Tech.
M.I.T.
Naval Post Graduate School
NC State University
Old Dominion University
Oregon State University
Prince George's College
Scripps Institution of Oceanography
Stockton State College
University Calif-Berkeley
University of Florida
University of Maryland-College Park
University of Maryland-Baltimore
University of North Carolina
University of N C-Seagrant Program
University of Virginia
Va. Inst. of Marine Science
Rutgers University

Others:

Allied Signal Aerospace Co.
Applied Physics Lab
Cape Hatteras Nat. Seashore
Coastal and Est. Res., Inc.
Coastal Science & Eng., Inc.
Dr. Cy Galvin
GEOMET Tech., Inc.
Mr. Hodges
Dr. Hylton
Mr. Mason
Mr. Rodgers
WCTI-TV
MEC Systems Corporation
Moffatt & Nichol, Eng.
N.C. Div. Coastal Management
Oregon Inlet & Waterways Commis.
Raleigh-Durham Airport
Mr. Rowland
Mr. Savage
Science Application Int'l. Corp
Sherwood Industries
SEASUN Power Systems

Foreign:

Christchurch, Barbados
Ministry of Works, Bahamas
Dalhousie University, Halifax Nova Scotia
Queen's University, Ontario (Canada)
Ministry of Construction, Coastal Division (Japan)
Norwegian Hydrodynamic Laboratories (Norway)
University of Sydney (Australia)